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Report to the Chairman, Subcommittee on Space Science and Applications, Committee on Science, Space, and Technology, House of Representatives

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SPACE OPERATIONS

Testing of NASA's Technical and Management Information System

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Information Management and
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The Honorable Bill Nelson
Chairman, Subcommittee on Space Science
and Applications
Committee on Science, Space,
and Technology
House of Representatives

Dear Mr. Chairman:

On February 26, 1988, we briefed your staff on the status of the development of the National Aeronautics and Space Administration's (NASA) Technical and Management Information System (TMIS). Our work was based on discussions with NASA and contractor officials, limited analysis of contractor and NASA documents, and our understanding of the contract, including its provisions for testing the new system. This report responds to a request from your office for information, by March 8, 1988, summarizing the material presented during the briefing for use at the committee's upcoming hearings. To further assist the committee, we are also including issues concerning the current status of TMIS' development based on our best understanding of the situation as of February 26, 1988.

In June 1987, NASA awarded a $333.7 million contract for the development of TMIS. When completed, this system is intended to support the design, development, and operation of the planned space station. NASA initially allocated $36.2 million for the development and operation of the first operational increment of TMIS, which included $27.4 million for development and $8.8 million for TMIS' operation through September 1988. Our reading of the contract indicates that the hardware and software for the first increment should have been designed, tested, and made fully operational at all 10 NASA user installations by February 1988.

However, as of February 1988:

- The NASA TMIS Project Manager estimated that NASA will have spent the $36.2 million by the end of March 1988.
- NASA had received only partial and incomplete test reports, which identified system problems that apparently still need to be corrected.

- The contractor estimated that all the capabilities of the first increment will not be fully tested and operational at all 10 NASA user locations until June 1988.

An agency document stated that NASA's Administrator planned to review the status of TMIS in early March 1988. We would expect that this review would address issues such as (1) how NASA plans to resolve the system problems noted in the contractor's test reports, (2) the impact these problems will have on the contractor's ability to meet its planned completion date of June 1988, (3) what additional funding beyond the $36.2 million will be needed to complete the first increment and operate the system through the end of fiscal year 1988, and (4) what impact the testing problems and associated delay, if any, might have on TMIS's overall schedule, cost, and ability to meet NASA's requirements.

Background

On June 2, 1987, NASA awarded a cost-plus-award-fee contract totaling $333.7 million over a 10-year period to Boeing Computer Services Company for all the resources necessary for the establishment of TMIS. When completed, TMIS will include an integrated system of technical and management processes, automated data processing (ADP) equipment, software, communication networks, and procedures intended to support the design, development, and operation of the planned space station. The system will provide 16 major ADP capabilities to aid NASA in performing 28 management and technical processes associated with the Space Station Program. For example, a NASA requirements document stated that the automated project management system capability will assist NASA in performing space station program processes such as planning, scheduling, budgeting, cost and financial analysis, contract management, and performance management. TMIS will provide these capabilities to NASA headquarters, all NASA centers involved with the Space Station Program, other government participants, international participants, contractors, and customers.

The requirements for TMIS—specific functions and capabilities that the system must provide to NASA—were identified in the TMIS functional requirements document dated June 30, 1986. This document served as the initial set of requirements from which the contractor would develop the system. The system is being designed and implemented in six increments, each adding additional capabilities to the system. NASA specified a minimum set of capabilities that must be included in the first increment, referred to as "Initial Operational Capability Prime" (IOC Prime). The eight capabilities the contractor plans to implement are data base

management, project management, document management, electronic mail, workstations, hardware, interfaces, and networking.

On April 2, 1987, NASA's Administrator allocated $36.2 million for the development and operation of IOC Prime. It is our understanding that the contractor was required to develop, test, and make operational the IOC Prime increment within 8 months after the contract start date of June 2, 1987, or by February 2, 1988. NASA allocated $27.4 million for this purpose, as well as an additional $8.8 million for operations through September 1988.

NASA's Plans for Testing TMIS

According to a TMIS project official, the procedures NASA planned to use for testing the system were intended to ensure that the approved functional requirements were satisfied by the hardware and software installed by the contractor. The contractor converted the functional requirements developed by NASA into 1,583 specific line-item requirements. The contractor then associated these requirements with the major system capabilities that TMIS would eventually provide.

The contractor's test plans, as submitted to NASA, describe three levels of testing that will be performed to ensure that the system meets the functional requirements before becoming operational—unit, integration, and acceptance testing. Unit testing is to be performed on each separate element (hardware or software unit) to verify that the unit performs according to specifications. Upon successful completion of unit testing, the hardware and software is subjected to integration testing, which evaluates the functioning of the integrated hardware and software units as system components. Integration testing focuses on the eight IOC Prime components, each of which would likely be composed of several integrated hardware and software units evaluated during development. The contractor reported that it had developed 192 scenarios to test the IOC Prime components.

Unit testing and initial integration testing is to be carried out in Reston, Virginia, at the TMIS Systems Integration Laboratory. Final integration and installation testing is to occur at the 10 NASA user installations.

Acceptance testing, the final phase of testing before operations, is also to be conducted at user installations. It evaluates the functioning of the integrated components as a total system. Upon successful completion of acceptance testing, NASA will accept the TMIS increment being installed. The contract provides that NASA shall be permitted to witness and/or

participate in all tests conducted by the contractor. It also requires the contractor to ensure that all testing is completed and to report the results to NASA.

The contractor is required to document the testing process by preparing test plans, procedures, and results. Test plans define the total scope of testing for a major TMIS hardware or software component, such as electronic mail or a data base management system. The plans are required to describe how the component will be quality tested and are used by the contractor to guide the development of test procedures. Test plans include a detailed description of the testing that will be performed, including unit, integration, and acceptance testing. Test plans are intended to facilitate NASA's assessment of planned testing efforts.

Test procedures for major system components include detailed test scenarios, test cases, a listing of the requirements to be satisfied by the testing, step by step instructions for testing, and expected test results. Test procedures are designed to facilitate component testing to ensure that contract products are ready for use and meet contract specifications and standards, such as those described in the TMIS functional requirements. Test reports include the detailed results of actual tests of hardware and software products that are required by the contract. Although the format of test reports is left to the discretion of the contractor, the contract requires that the reports include (1) a summary of the test results, including an analysis of the functional capability provided by the system, as determined by testing, and (2) suggested improvements in system design and/or operation.

Status of IOC Prime

NASA initially allocated $36.2 million for IOC Prime, but most of these funds have been spent and the system was not fully tested or operational as of the end of February 1988. Specifically, on February 5, 1988, the NASA TMIS Project Manager estimated that the $36.2 million will be spent by the end of March 1988. According to the contractor, partial TMIS capabilities will be available to some users by March 1988. However, because additional TMIS hardware will not be installed and tested until late spring, complete IOC Prime capabilities are not expected to be fully installed, tested, and accepted at all 10 NASA sites until June 1988.

Regarding testing, the contractor, on February 5, 1988, stated that unit and integration testing for the IOC Prime components was to be completed at the systems integration laboratory and at five NASA installations by the end of February. The contractor also stated that

(1) acceptance testing for these locations was planned to be completed during March 1988, and (2) acceptance testing at the remaining five installations was planned for completion by June 1988, at which time IOC Prime components would be usable by all NASA installations.

Although the contractor stated that unit and integration testing should be completed by the end of February 1988, only limited unit and integration test reports had been submitted to NASA for its review and approval as of February 26. In reviewing them, we found that unit test reports were available for only one of the eight IOC Prime components. Further, only four of the nine test scenarios required to be performed in the test plan for this one component were documented. The test report listed 19 deviations ranked as "Level E," which the contractor characterized as high in severity or frequency and avoidable, but hard to detect or correct. For example, one of the deviations identified was that the built-in user assistance information in the document management system was incomplete, inconsistent, or poorly worded. This could have an impact on the hundreds of TMIS users who would rely on such information.

Integration test reports were submitted to NASA for all five sites for which the contractor said integration testing was complete. However, our review of the test reports showed the tests were incomplete in that they covered only 29 to 33 of the 192 planned test scenarios. Initial integration test reports prepared by the contractor included a detailed listing of tested functional requirements and rated them as (1) satisfied, (2) not satisfied, or (3) only partially satisfied by the system. Subsequent integration test reports we reviewed no longer identified the specific requirements that were not satisfied by the TMIS IOC Prime increment tested.

Scope and Methodology

We developed the information for this report as part of our ongoing work on the development of TMIS. We met with NASA project officials and contractor representatives to determine the nature, extent, and status of testing activities for the first increment of TMIS, IOC Prime. We also reviewed the TMIS contract, the system's functional requirements document, and contractor test plans and reports submitted to NASA as of February 26, 1988. However, to accommodate the committee's need for information in time for planned hearings, we did not (1) discuss our findings or the system problems noted in the test reports with NASA or the contractor, or (2) assess the circumstances surrounding the limited

and apparently incomplete documentation of unit and integration testing. As requested by your office, we did not obtain official agency or contractor comments on a draft of this report.

As arranged with your office, we are providing copies of this report to NASA and the contractor. We will also make copies available to other interested parties upon request.

Sincerely yours,

Ralph V. Carlone

Ralph V. Carlone
Director

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